Pacific Science (1981), vol. 35, no. 1

Insect Damage to Leaves of Two Varieties of *Metrosideros collina* subsp. *polymorpha*[1]

M. A. B. LEE[2]

ABSTRACT: Leaves from two varieties of *Metrosideros collina* subsp. *polymorpha*, var. *polymorpha* and var. *glaberrima*, were sampled in two successional communities on the island of Hawaii. One variety, *polymorpha*, has coriaceous leaves with thick pubescence on the underside, and the other, *glaberrima*, has thin leaves and no pubescence. Variety *polymorpha* was less frequently attacked by insects at both study sites. Damage by leaf-eating insects was more frequent on variety *glaberrima* and may be related to lack of pubescence. Differences in the frequency of insect damage both between varieties and between study sites reflected inversely differences in the frequency of occurrence of the two varieties. Greater frequency of occurrence was related to a lower frequency of insect damage.

INSECT PREDATION on plants and the development in plants of protective mechanisms against insect attack have been recognized in recent years as important factors in plant ecology. Several different types of defense mechanisms have been studied including timing of leaf production and chemical defenses. Levin (1973) and Johnson (1975) have suggested that leaf pubescence may be a protective adaptation against insect damage.

This study investigates insect damage to the leaves of two varieties of *Metrosideros collina* (J. R. and G. Forst.) Gray subsp. *polymorpha* (Gray) Rock, commonly known as ʻōhiʻa lehua, in two successional communities on the island of Hawaii. The two varieties differ in leaf shape, texture, and pubescence. Leaves of *M. collina* subsp. *polymorpha* var. *polymorpha* are obovate, thick and coriaceous, and dull or dark green in color. They have thick gray pubescence on the underside. The leaves of *M. collina* subsp. *polymorpha* var. *glaberrima* (Levl.) are elliptical, thin, and light green. No pubescence is present.

The purpose of this study is to see if there are differences between these two varieties in the amount and type of insect damage sustained that may reflect differences in leaf characteristics.

METHODS

The two study sites were located on different-aged lava flows of similar altitude and rainfall on the east flank of Mauna Loa (Figure 1). The younger site was a 1942 lava flow and the older site was an 1855 lava flow. According to Atkinson (1970) these two sites represent different stages in a succession he terms rockland–*Dicranopteris* fernland–*Metrosideros*/*Cibotium* forest. *Metrosideros collina* subsp. *polymorpha* was the only tree species on the 1942 lava flow where it reached a maximum height of 3 m. At the 1855 study site *Metrosideros* was the principal tree species with heights up to 5 m.

Samples were taken at points 10 m apart along three regularly spaced 50 m line transects running transverse to the slope. One individual of each variety was sampled at each point. At the 1855 site 15 additional individuals of *Metrosideros collina* var. *poly-*

[1] This paper is a section of a Ph.D. Dissertation presented to the University of Hawaii. Manuscript accepted 15 December 1980.

[2] University of Hawaii, Department of Geography, Honolulu, Hawaii 96822. Present address: University of Iowa, Department of Geography, Iowa City, Iowa 52242.

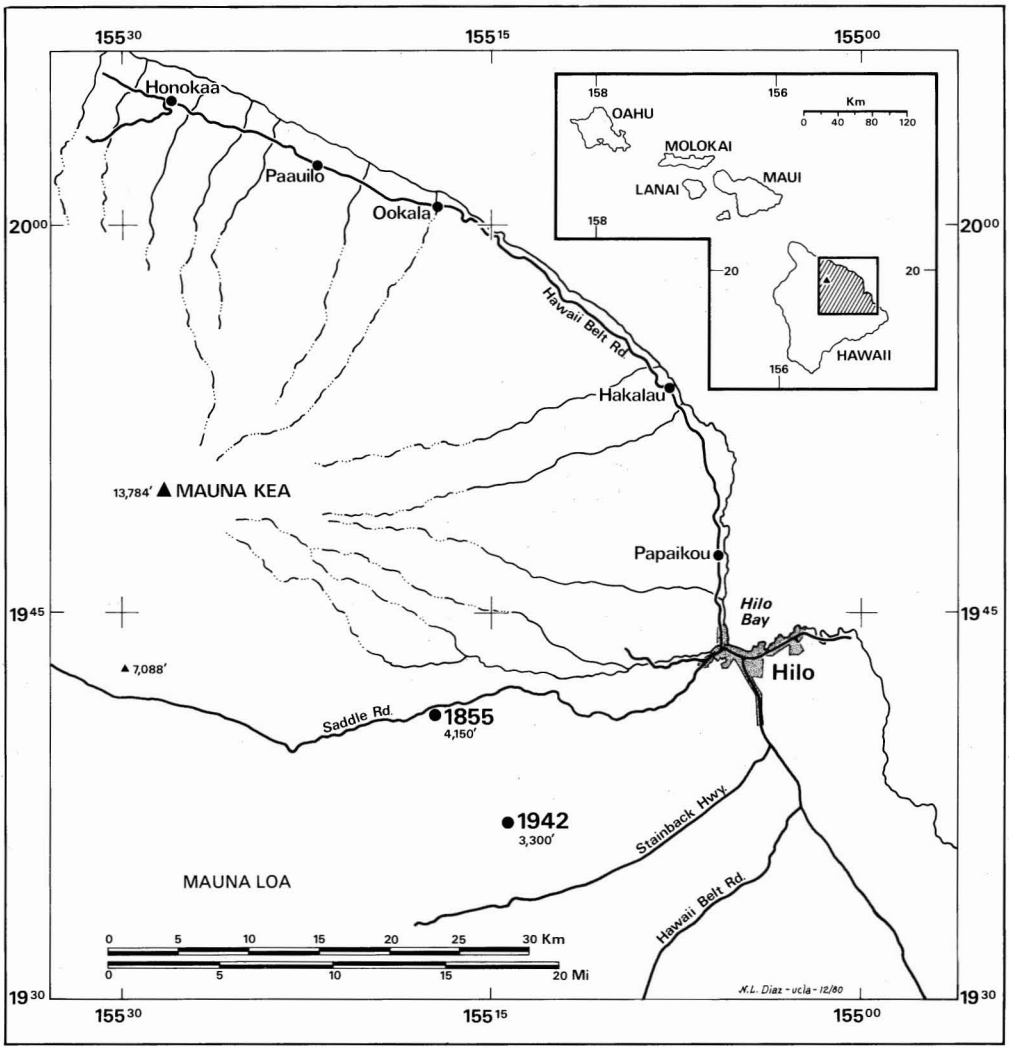

FIGURE 1. Location of the study sites.

morpha were sampled in connection with a different project. These additional samples are included here.

Leafy branches were taken from each tree both from inside and outside the NE quadrant of each canopy. The number of leaves on a branch, and thus the number of leaves sampled per individual, varied. Some trees were producing a flush of new leaves and others were not. In addition, the number of older leaves remaining on each branch varied. The mean number of leaves sampled from each tree was 15.

The sampled leaves were examined while fresh. Insect damage was identified and its frequency measured as the percentage of sampled leaves damaged by insects. Damage was also categorized by type.

Most of the insect damage observed could not be attributed to a particular insect species, so only generalized categories of types of insect damage were formed. Observed damage was divided into three categories: galls, holes, and feeding spots. Two genera of the family Psyllidae, order Homoptera, *Trioza* and *Kuwayama*, lay eggs in

TABLE 1

FREQUENCY OF OCCURRENCE AND TYPE OF INSECT DAMAGE FOR TWO VARIETIES OF *Metrosideros collina* SUBSP. *polymorpha*

STUDY SITE	VARIETY	FREQUENCY OF OCCURRENCE	NUMBER OF LEAVES SAMPLED	FREQUENCY OF INSECT DAMAGE (%)*	FREQUENCY OF TYPES OF INSECT DAMAGE (%)†		
					GALLS	FEEDING SPOTS	HOLES
1942	*polymorpha*	40	240	84	79	41	11
	glaberrima	30	259	93	33	51	26
1855	*polymorpha*	100	734	53	65	59	14
	glaberrima	50	202	81	85	29	24

*Measured as the percentage of sampled leaves having insect damage.
†Measured as the percentage of damaged leaves having the particular type of damage.

Metrosideros leaves, producing galls. Several insect species, particularly of the order Lepidoptera, are known to chew the leaves of this tree, producing the holes. A number of different insects suck the sap of the leaves, causing feeding spots. These include species in the families Lygaeidae and Miridae of the order Heteroptera (Swezey 1954).

The frequency of occurrence of the two varieties of *Metrosideros* was determined from 15 regularly spaced $9m^2$ quadrats at each site. Differences in the frequency of insect damage and of damage types are evaluated in this study using the chi-square test. All differences discussed are significant at the .05 level.

RESULTS

The results of the sampling are shown in Table 1. At both study sites *Metrosideros collina* var. *polymorpha* is less frequently attacked by insects than is *M. c.* var. *glaberrima*. This difference is greater at the 1855 site, but is statistically significant in both cases. Both varieties suffer significantly less frequent damage at the 1855 site than at the 1942 site.

The importance of the different types of insect damage sustained varies both by variety and by study site. At the 1942 study site, *M. c.* var. *polymorpha* suffers most frequently from galls, and galls are significantly more frequent on these leaves than on the leaves of *M. c.* var. *glaberrima*. Sap-feeding insects are responsible for most of the damage found on the leaves of *M. c.* var. *glaberrima* in this community, but this variety also has significantly more damage from leaf-eating insects than *M. c.* var. *polymorpha*.

Samples taken from the 1855 lava flow have a somewhat different pattern. Here, although galls are still observed frequently on *Metrosideros collina* var. *polymorpha*, they are more frequent on the leaves of *M. c.* var. *glaberrima*. As in the younger community, holes remain significantly more important on the leaves of the latter variety.

Differences in the frequency of insect damage between varieties and study sites mirror differences in the frequency of occurrence of the two varieties. *Metrosideros collina* subsp. *polymorpha* var. *polymorpha* is more frequent at both sites, although the difference in frequency of occurrence between the two varieties is greater in the 1855 site. Both varieties increase in frequency from the 1942 site to the 1855 site. Thus, increases in frequency of occurrence appear to be related to decreases in the frequency of insect damage.

DISCUSSION

The two varieties sampled here differ both in the frequency and the type of insect damage sustained. *Metrosideros collina* subsp. *polymorpha* var. *polymorpha*, with thicker leaves and with pubescence on the underside, is less frequently damaged by insects in both communities where sampled. However, be-

cause of the apparent inverse relationship between the frequency of occurrence and the frequency of insect damage, it is uncertain whether this difference can be truly attributed to differences in leaf characteristics.

Differences in the frequency of types of insect damage, both between the two varieties studied and between the two study sites, are somewhat difficult to interpret. The lower frequency of holes in *Metrosideros collina* subsp. *polymorpha* var. *polymorpha* may result from the pubescence on the leaves, which may protect them from leaf-eating insects. The holes created by these insects, however, always involved the entire leaf surface. No examples were observed in which only the upper surface of the leaf was eaten. Because this pubescence is only on the underside, it would not be expected that it would serve as a protection against gall-making and sap-feeding insects. These types of insects are apparently restricted to the upper surface of the leaf. No examples of either form of damage were found on the undersides of the leaves.

There are no consistent differences between the two varieties in the frequency of either galls or feeding spots. One of the complicating factors here is that the two study sites are successional communities. Through succession, the insect populations are undoubtedly changing, and these changes might be expected to produce changes in the frequency of different types of insect damage.

Both varieties suffer more frequent damage at the younger site, and changes in the frequency of occurrence of these two varieties appear to be related to differences in the frequency of damage. This too may be a successional phenomenon. If plant frequency increases faster than insect populations, then the frequency of insect damage will decrease.

LITERATURE CITED

ATKINSON, I. A. E. 1970. Successional trends in the coastal and lowland forest of Mauna Loa and Kilauea volcanoes, Hawaii. Pac. Sci. 24:387–400.

JOHNSON, H. B. 1975. Plant pubescence: An ecological perspective. Bot. Rev. 41:233–235.

LEVIN, D. A. 1973. The role of trichomes in plant defense. Q. Rev. of Biol. 48:3–15.

SWEZEY, O. H. 1954. Forest entomology in Hawaii. Bernice P. Bishop Mus. Spec. Publ. 44.